

STEROIDS INFORMATION SHEET

Ergogenic (performance-enhancing) drugs agents include anabolic steroids, growth hormone and erythropoietin. Stimulants may also be used as ergogenic drugs because of their ability to mask fatigue. Some drugs prevent the detection of ergogenic drugs in urine. Ergogenic drugs carry serious risks. Health care professionals should educate patients about the effects of these drugs and counsel patients not to use them.

Drug use by athletes has become commonplace. Many athletes use performance-enhancing drugs, known as ergogenic drugs, to improve their athletic ability beyond the levels otherwise anticipated.

Examples of ergogenic drugs are anabolic steroids, growth hormone and erythropoietin. Some athletes consider stimulants to be ergogenic because of their ability to mask fatigue, some may use drugs to aid them in circumventing drug testing.

Reasons for their use: to increase muscle strength and size, to prevent and treat sports injuries, to improve sexual performance, to increase sexual organ size, and to improve physical performance. It was also noted that these students lack medical knowledge about the side effects of steroids.

Ergogenic Drugs

The following discussion focuses on anabolic steroids, growth hormone, erythropoietin and stimulants.

Possible Side Effects of Ergogenic Drugs

beta-Agonists (eg, clenbuterol*)	increase muscle mass, strength
Erythropoietin	increases endurance
Growth hormone	increases muscle mass, strength

Stimulants

Amphetamines	increase strength, alertness, endurance
Caffeine	reduces fatigue
Ephedrine	increases alertness
Phenylpropanolamine	increases alertness
Pseudoephedrine	increases alertness
Synthetic testosterone derivatives (eg, anabolic steroids)	increase muscle mass, strength

* Not available in the United States.

† Drugs that stimulate endogenous growth hormone are amino acids, beta-blockers, bromocriptine, clonidine, gonadotropin-releasing hormones, levodopa and vasopressin.

Anabolic Steroids

Anabolic steroids are synthetic derivatives of the male sex hormone testosterone. Some athletes use anabolic steroids to increase lean body mass and strength and to reduce recovery time between workouts. However, controlled studies of the effect of these drugs on muscle strength are difficult to conduct. Some athletes use megadoses of these drugs, sometimes 100 times the normal dose; it is unethical to administer such doses to healthy persons in clinical trials. Additionally, the severity of side effects occurring at these doses precludes a truly blinded study. Most data are based on anecdotal evidence and the results are difficult to interpret.

Anabolic steroids promote tissue growth by stimulating protein synthesis and retarding protein catabolism. They promote messenger RNA synthesis, thereby stimulating synthesis of protein in muscle cells. Besides anabolic, or tissue-building, properties, these agents also have androgenic or masculinizing, properties. A purely anabolic steroid has not been isolated. Determination of anabolic or androgenic response depends on the location of the cell type, not the nature of the steroid.

During periods of stress and intense training, levels of endogenous cortisol increase significantly, resulting in a negative nitrogen balance and muscle wasting. Anabolic steroids reverse these catabolic effects by displacing cortisol from its receptors, allowing the athlete to continue training at a high level. The athlete needs to maintain a high-protein, high-calorie diet before and during anabolic steroid use, in response to the body's increased ability to synthesize protein and prevent protein breakdown.

Most of the information on the adverse effects of anabolic steroids is obtained from patients receiving these drugs for legitimate medical reasons: certain anemias, hereditary angioedema and certain cases of breast cancer. In these patients, anabolic steroids are found to produce a wide array of adverse effects, which may differ from those in the

athletes who use extremely large doses. Some male athletes administer other drugs to combat the deleterious effects of anabolic steroids. Gonadotropin-releasing hormones (GnRH), human chorionic gonadotropin (hCG) and menotropins are administered to stimulate the production of endogenous testosterone and maintain testicular function.

Side Effects of Anabolic Steroids*

Endocrine and Reproductive

Male

Testicular atrophy	Oligospermia and azoospermia
Gynecomastia	Prostatic hypertrophy
Prostatic carcinoma	Priapism
Altered glucose metabolism (insulin resistance, glucose intolerance)	
Altered thyroid profile (decreased T3, T4, TSH, and TBG)	
Decreased levels of reproductive hormones	

Female

Masculinization	Hirsutism
Deepening of the voice	Clitoral hypertrophy
Menstrual irregularities	Male pattern alopecia
Altered glucose metabolism (insulin resistance, glucose intolerance)	
Altered thyroid profile (decreased T3, T4, TSH, and TBG)	

Cardiovascular and Hematologic

Decreased HDL cholesterol	Increased LDL cholesterol
Hypertension	Clotting abnormalities
(sodium and water retention)	Myocardial infarction
Left ventricular hypertrophy	Cerebrovascular accident

Renal

Elevated BUN, creatine	Wilms' tumor
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Dermatologic

Acne	Alopecia
Temporal hair recession	Skin rash

Hepatic

Elevated liver function test results	Cholestatic jaundice
Hepatocellular carcinoma (> 24 mo use)	Peliosis hepatis (> 6 mo use)
Hepatoma	Hepatitis

Musculoskeletal

Increased risk of musculotendinous injury
Avascular necrosis of femoral heads
Premature epiphyseal closure (adolescents)

Subjective

Edema	Muscle spasm
Anxiety	Increased urine output
Headaches	Dizziness
Nausea	Euphoria
Urethritis	Scrotal pain
Irritability	Suicide ideation or attempts

Psychological

Aggressive behavior	Mood swings
Increased or decreased libido	Dependency
Acute psychosis	Manic and/or depressive episodes

Miscellaneous

AIDS transmission as a result of needle sharing

*Classified as schedule 3 controlled substances.

BUN	=	blood urea nitrogen
HDL	=	high-density lipoprotein
LDL	=	low-density lipoprotein
T3	=	triiodothyronine
T4	=	thyroxine
TBG	=	thyroxine-binding globulin
TSH	=	thyroid-stimulating hormone

beta-Agonists

Some long-acting beta-agonists also enhance muscle strength and size. Studies in animals have shown that stimulation of beta-adrenergic receptors increases muscle mass, body weight and muscle protein synthesis.

Clenbuterol, a selective beta₂-agonist used for its anabolic effect, has a half-life of 34 hours. It is not available in the United States. Adverse effects of clenbuterol are similar to those of other beta₂-agonists: tachycardia, tremor, palpitations, nausea, and decreased serum potassium concentrations.

Growth Hormone

The use of growth hormone escalated dramatically in the late 1980s, when drug testing for anabolic steroids became routine. The use of drugs and nutritional supplements that raise endogenous growth hormone levels also increased. The amino acids arginine, ornithine, and lysine, in combination or alone, may increase levels of endogenous growth hormone. beta-Blockers, bromocriptine, clonidine, levodopa, and vasopressin also increase its release.

Growth hormone exerts many physiologic effects, primarily the stimulation of somatic growth. A positive nitrogen balance and an overall anabolic effect result from the transportation of amino acids into tissue and subsequent protein synthesis. Additionally, growth hormone stimulates the mobilization of lipids from adipose tissue and increases oxidation as a source of energy, thus sparing muscle glycogen. However, there are no studies to assess the ergogenic effects of growth hormone in athletes.

Reported adverse effects of growth hormone in patients receiving the drug for medicinal purposes include acromegaly, gigantism, glucose intolerance, myopathy, heart disease, arthrosis, hyperlipidemia, muscle weakness, hypothyroidism, and disfigurement associated with bony overgrowth.

Creutzfeldt-Jakob disease, a fatal neurologic disorder with a 15-year incubation period, has also been associated with the use of growth hormone. Until 1985, growth hormone was extracted from cadaver pituitary glands. Some samples were contaminated with the slow-growing virus that causes Creutzfeldt-Jakob disease. Since there was no method to test for the presence of this contaminant, in 1985 human growth hormone was withdrawn from the market. Recombinant growth hormone became available later that year.

Erythropoietin

Taking erythropoietin and infusing red blood cells, either one's own or a donor's--a process known as "blood doping," elevates the number of red blood cells in the circulation, thereby increasing the oxygen-carrying capacity of the blood and improving endurance. Marathon runners, cyclers and skiers may gain the greatest benefit. Although there are no studies assessing the ergogenic effect of erythropoietin, its effect on endurance is obvious.

Erythropoietin use is associated with severe adverse effects: hematocrit levels may become dangerously high, making the blood viscous and leading to poor circulation. Thrombosis or myocardial infarction may occur. Recently, its use was suspected in the deaths of four cyclists from the Netherlands. Nevertheless, athletes continue to use erythropoietin because there are no tests to detect its use and its ergogenic effects are sustained long after administration.

Stimulants

Many types of stimulants are available to the athlete: amphetamines, pseudoephedrine, phenylpropanolamine, ephedrine, and caffeine. Their use may enhance performance by allowing the athlete to feel more alert and delay fatigue brought on by prolonged exertion. Stimulants also generate feelings of self-confidence, well-being, and aggression. Athletes who compete in sports, in which speed, power, and endurance are necessary, such as running, speed skating, swimming and cycling, may be most affected. Athletes who compete in sports defined by weight classes, such as boxing, wrestling, horseback riding and judo, may use them for their anorexic properties.

Most adverse effects of amphetamines are an extension of their pharmacologic action. Restlessness, dizziness, tremor, irritability, hyperactive reflexes, increased libido, insomnia, confusion, delirium and hallucinations occur from excessive central nervous system stimulation. Cardiovascular effects include headaches, chills, flushing, palpitations, angina, arrhythmias, hypertension, hypotension, bradycardia, tachycardia, and cardiovascular collapse. Adverse gastrointestinal effects include vomiting, abdominal pain, and decreased appetite.

Some athletes claim that caffeine has an ergogenic effect, while others say it makes exercise easier. Caffeine used before a tough workout may enable the athlete to work harder without perceiving the effort as more intense. The athlete may feel more alert and energetic. In large doses, caffeine has a diuretic effect. One review concluded that caffeine improves performance during prolonged exercise of moderate intensity but not during short-term or incremental exercise of high intensity.

Methods Used to Defeat Drug Testing

Since drug testing became routine, athletes have used various methods to render the testing ineffective. Some athletes switched from anabolic steroids, which are detectable in the urine, to proteins like growth hormone, GnRH and erythropoietin, which are not. Others administered drugs concomitantly with ergogenic drugs to mask the presence of ergogenic drugs in the urine, dilute the urine or decrease the excretion of ergogenic drugs. The information below lists drugs used to mask the presence of ergogenic drugs and their effects.

Effects of Drugs Used to Mask the Presence of Ergogenic Drugs in the Urine

Diuretics	dilute the urine, enable rapid weight loss
Epitestosterone	decreases the ratio of testosterone to epitestosterone
Hormones	decrease the ratio of testosterone to epitestosterone
Growth hormone	
Menotropins	
Gonadotropin-releasing hormone	
Uricosuric drugs	inhibit the excretion of ergogenic drugs
Phenylbutazone	
Probenecid	
Sulfinpyrazone	

Anabolic steroids are detected in the urine through an analysis of the ratio of testosterone to epitestosterone (an epimer of testosterone). In the urine of a normal male, the ratio of testosterone to epitestosterone (T/E ratio) is 6:1. Administration of anabolic steroids decreases levels of epitestosterone that suggests the presence of anabolic steroids with a high degree of specificity.

To avoid testing positive, some athletes administer agents that decrease the T/E ratio. Epitestosterone (which is available for veterinary use) can be administered for this purpose, either alone or in combination with an injectable testosterone preparation. Side effects are similar to those induced by anabolic steroids. Hormones such as hCG, menotropins, and GnRH can also be used. They stimulate endogenous secretion of both epitestosterone and testosterone and may normalize an elevated T/E ratio. In addition, a hormone such as GnRH is not detectable in the urine and can itself stimulate the secretion of growth hormone. The ergogenic benefit of GnRH is short-lived, however and long-term use is necessary to sustain it.

Another method used by athletes is to dilute the urine by taking diuretics, thereby decreasing the concentration of any ergogenic drug in the urine and reducing the likelihood of drug detection. Diuretics may also decrease weight, which may be advantageous if the athlete is in a sport requiring assignment to a weight class. Side effects of diuretics include headache, nausea, vomiting, dizziness, hypovolemia, muscle cramps and electrolyte imbalances.

Drugs that inhibit the excretion of many drugs, including anabolic steroids, are also used to defeat drug testing. Uricosuric agents, such as probenecid, phenylbutazone (a veterinary product), and sulfinpyrazone, are used for this purpose.

Potential Solutions

Drug use may be curtailed by routine and unexpected drug testing and by providing education about the use and side effects of these drugs. Using self-reporting questionnaires, the NCAA documented a decrease in the use of anabolic steroids, apparently related to drug testing.

The benefits of educating athletes to the dangers of ergogenic drugs are more difficult to quantify. The Council on Scientific Affairs of the American Medical Association issued recommendations for ensuring the health of the adolescent athlete, one of which is to provide information about drug-related health hazards. Health care professionals can offer

specific suggestions (as seen below) to the athletes. Despite the risks associated with the use of ergogenic drugs, many athletes and their coaches continue to perceive them as harmless.

Suggestions for the Athlete Considering Drug Use

1. Know the facts about all drugs you take--both prescription and over-the-counter
2. View your body as something to keep safe from harm and free from contamination
3. Think about your plans for the future and your health
4. Go for natural methods that allow you to look good and perform well
5. Enjoy and appreciate your uniqueness; don't ever try to be somebody else
6. When in doubt, check it out with somebody who really cares
7. After considering all possible consequences, have the courage to make a good decision based on healthy practices

Although scientific evidence that drugs aid in athletic performance is controversial and sparse, athletes still use them based on anecdotal information and their belief in the drugs' effectiveness. Athletes may ignore long-term consequences of these drugs and put themselves at risk for severe adverse effects. Health care professionals are in a unique position to educate athletes about potential adverse effects of both prescription and nonprescription drugs and to encourage them to stop using these drugs.

MUSCLE BUILDING - Androstenedione

Androstenedione was developed by East German researchers who used it beginning in the 1970s in an attempt to boost the performance of Olympic swimmers and other athletes. Andro was introduced commercially in the United States in the mid-1990s. Marketers widely claim that a 100-milligram dose of androstenedione increases the male hormone testosterone by up to 300 percent. The increase, according to marketers, lasts for about 3 hours.

Androstenedione is a precursor hormone in the production of testosterone. Most of the testosterone in men is produced by the testes that is responsible for facial hair, a lower voice, bigger muscles and other male characteristics. Testosterone is produced in both men and women by the glands located atop each kidney called the adrenal glands. The adrenals, like the testicles, are part of the endocrine system, which secrete hormones directly into the bloodstream. Testosterone and other hormones are governed by a feedback system in the body that stimulates the production of a specific hormone when levels fall too low. The same system reduces production when optimal levels are reached.

Proponents argue that the body directly converts andro to testosterone. An elevated level of the male hormone allows athletes to train harder and recover more quickly. Few scientific studies have been done on the use of androstenedione, according to Todd B. Nippoldt, M.D., an endocrinologist at Mayo Clinic, Rochester, Minn. "There's not even an answer to the question: 'What does it do?' There just isn't enough good published research to back up the claims that if you take andro then you will see a 300 percent increase in testosterone levels."

Androstenedione is naturally found in meat and some plants. But the pills and capsules on the market deliver it in a concentrated form that may carry unwanted consequences. Indeed, the labels of many andro products warn that androstenedione should not be used by women, anyone under 18 years old, or people suffering from any medical conditions, including diabetes, heart disease, psychological disorders and prostate hypertrophy.

Steroids

The team physicians say that androstenedione has raised concerns about serious health risks and an "unfair advantage" in competition. They also warn of potential complications such as acne, breast enlargement, liver and heart problems and personality disorders resulting from andro use.

Creatine

Creatine monohydrate is a compound produced by the body that helps release energy in muscles. Unlike androstenedione, scientific research indicates that creatine can boost short-term bursts of power. "Most of the research points to improvements like one more repetition on a maximum-weight bench press or increased speed during cycling sprints of very short duration," says Dr. Laskowski. "Some studies have shown an increase in lean muscle mass with creatine. As a result, we've got this hype of creatine producing steroid-like effects without the side effects."

Creatine helps muscles make and circulate more adenosine triphosphate (ATP), the fuel the body uses for quick, explosive activity of short duration like weightlifting or sprinting. Creatine also reduces energy waste products. As a result, it's purported to enhance performance and decrease fatigue.

A normal liver makes about 2 grams of creatine each day. Creatine also is readily available from meat in your diet. Creatine levels are relatively easily maintained, and muscles can store creatine. The kidneys remove excess levels of the substance, which casts some doubt on whether creatine supplements are of any value to someone who already has a high muscle creatine content.

There also are serious questions concerning long-term use of creatine.

"Whether the kidneys can process that much creatine for a number of years is a prime worry," since "Creatine occurs naturally in foods, but no one knows what a supplemental dose will do over a long period of time."

In addition, creatine tends to draw water away from the body into muscle cells, which can lead to serious dehydration. Therefore, people using creatine should make sure they drink plenty of water or other fluids. One other aspect is that like andro, creatine is not classified as a drug, so there are no guarantees of its purity. "It depends on the manufacturer, the place you buy it and things like that."

Dietary Supplements – Contaminants Found

This has not stopped some coaches and players from advocating the use of creatine. With the overwhelming use, in addition to the risk of long-term side effects, people may substitute it for proper training and think: 'I can get away with practicing a little less because I'm taking creatine.'"

Despite the testimonials to muscle size and strength, there is no evidence that andro, creatine or any other substance enhances athletic performances over what could be attained by practice, training and proper nutrition. "There's really no data that translates into a performance-type situation." "Hitting a home run" certainly requires a lot more than being able to lift 10 pounds more, one more time; like speed, agility and reflexes. There's absolutely no data that any of these claimed performance-enhancing substances do anything to improve those."

Anabolic Steroids – Addictive?

Evidence that megadoses of anabolic steroids can affect the brain and produce mental changes in users poses serious questions about possible addiction to the drugs, it has been found that long-term steroids users do experience many of the characteristics of classic addiction: cravings, difficulty in ceasing steroids use and withdrawal symptoms.

From some studies that included a group of high school seniors who had developed a psychological, if not physical, dependence on anabolic steroids. Adolescent users exhibit a prime trait of addicts-denial. They tend to overlook or simply ignore the physical dangers and moral implications of taking illegal substances. Certain delusional behavior that is characteristic of addiction can occur. Some athletes who "bulk up" on anabolic steroids are unaware of body changes that are obvious to others, experiencing what is sometimes called **reverse anorexia**.

Supply And Demand - The Black Market

Until recently most underground steroids were legitimately manufactured pharmaceuticals that were diverted to the black market through theft and fraudulent prescriptions. More effective law enforcement coupled with greater demand forced black marketers to seek new sources. Now black-market anabolic steroids are either made overseas and smuggled into the United States or are produced in clandestine laboratories in this country. These counterfeit drugs may present greater health risks because they are manufactured without controls and thus may be impure, mislabeled, or simply bogus.

Sales are made in gyms, health clubs, on campuses and through the mail. Users report that suppliers may be drug dealers or they may be trainers, physicians, pharmacists or friends. Users do not find it hard to buy the drugs or to learn how to use them. Many of them rely on an underground manual, a "bible" on steroids that circulates around the country.

Safe-And Healthy - Alternatives

Anabolic steroids may have a reputation for turning a wimp into a winner or a runt into a hulk, but the truth is that it takes a lot more to be a star athlete. Athletic prowess depends not only on strength and endurance, but also on skill and mental acuity. This depends on diet, rest, overall mental and physical health and genes. Athletic excellence can be, and is, achieved by millions without reliance on dangerous drugs.

Fighting Back - Testing - Treatment - Legislation - Education

The major national and international sports associations enforce their ban against anabolic steroids by periodic testing. Testing, however, is controversial. Some observers say the tests are not reliable, and even the International Olympic Committees tests, considered to be the most accurate, have been challenged. Athletes can manipulate results with "masking agents" to prevent detection, or they can take anabolic steroids that have calculable detection periods. Despite the problems, testing remains an important way of monitoring and controlling the abuse of steroids among athletes. Efforts are underway to make testing more accurate.

Treatment programs for steroids abusers are just now being developed as more is learned about the habit. Medical specialists do find persuasion is an important weapon is getting the user off the drug. They attempt to present medical evidence of the damage anabolic steroids can do to the body. One specialist notes that medical tests, such as those that show a lowered sperm count, can motivate male athletes to cease usage. One health clinic considers the anabolic steroids habit as an addiction and structures treatment around the techniques used in traditional substance abuse programs. It focuses on acute intervention and a long-term follow-up, introducing nonsteroids alternatives that will maintain body fitness as well as self-esteem.

Both Federal and State governments have enacted laws and regulations to control anabolic steroids abuse. In 1988, Congress passed the Anti-Drug Abuse Act, making the distribution or possession of anabolic steroids for nonmedical reasons a Federal offense. Distribution to minors is a prison offense. In 1990, Congress toughened the laws, passing legislation that classifies anabolic steroids as a controlled substance. The new law also increases penalties for steroids use and trafficking. To halt diversion of anabolic steroids onto the black market, the law imposes strict production and record keeping regulations on pharmaceutical firms. Over 25 states have passed laws and regulations to control steroids abuse, and many others are considering similar legislation.

Prevention, by education, is the best solution to halting the growing abuse of anabolic steroids. The time to educate youngsters is before they become users. Efforts must not stop there, however. Current users, as well as coaches, trainers, parents, and medical practitioners need to know about the hazards of anabolic steroids. The young need to understand that they are not immortal and that the drugs can harm them. An education campaign must also address the problem of covert approval by some members of the medical and athletic communities that encourages steroids use. The message needs to be backed up by accurate information and spread by responsible, respected individuals.

Helpful Resources:

NIDA Hotline

1-800-662-HELP

Operated by the National Institute on Drug Abuse, this is a confidential information and referral line that directs callers to drug abuse treatment centers in their local community.

NCADI

1-800-729-6686

The National Clearinghouse for Alcohol and Drug Information (NCADI) provides information on all drugs, including alcohol. Free materials on drug abuse are also available. If you wish to write NCADI, the address is P.O. Box 2345, Rockville, MD 20852.